QUICK START GUIDE

Apollo4 Plus EVB Display Kit (Shield Board Revision 1)

Ultra-low Power Apollo SoC Family

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1. Introduction

This document provides guidance in setting up the Display Kit hardware, part number AMAP4PDISP, revision 1, on the Apollo4 Plus Evaluation Board (EVB), revision 2, to get started executing memory and display examples and measuring power consumption in various configurations. The Apollo4 Plus Display Kit is also intended to provide an introduction to the GUI Builder.

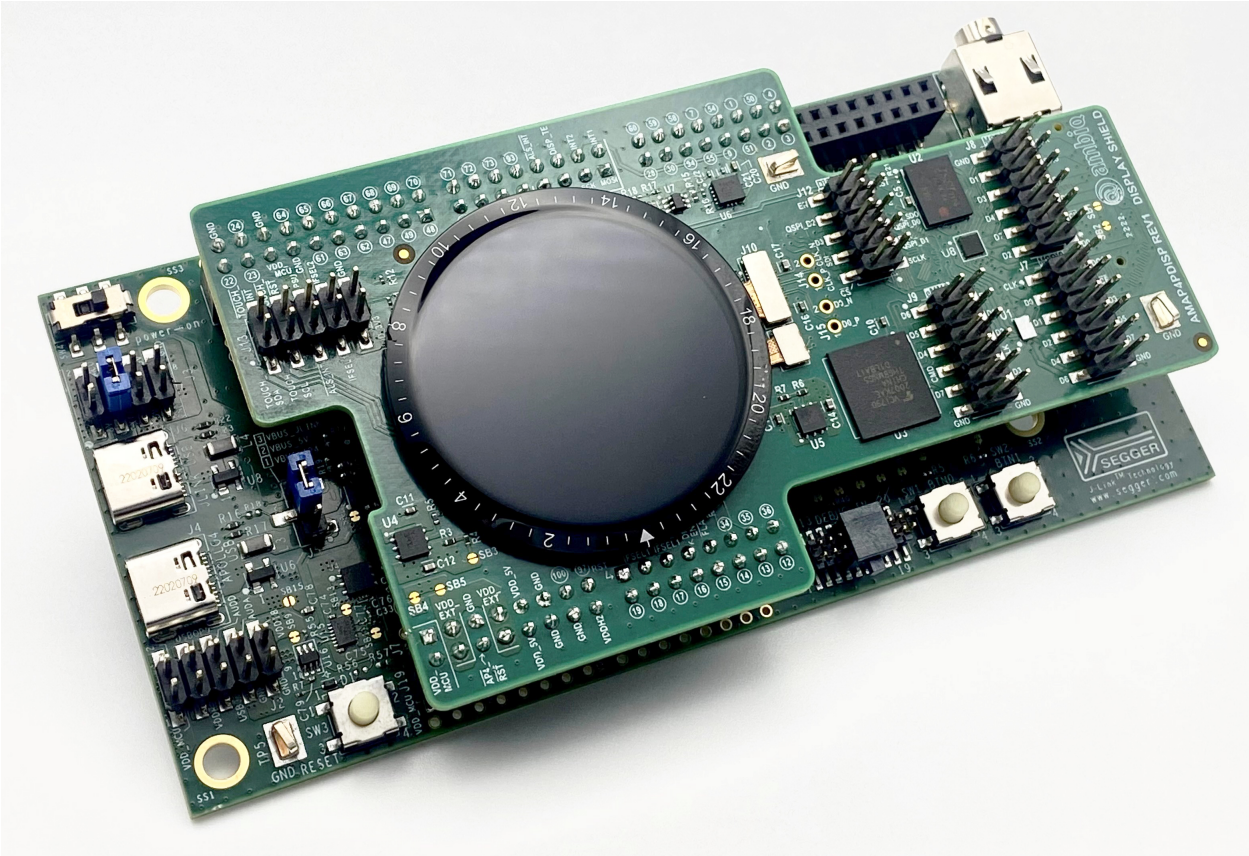

Figure 1. Apollo4 Plus Display Kit

2. Document Revision History

Table 1: Document Revision History

Rev #	Date	Description
1.0	Sep 2022	Document initial public release.
1.1	Nov 2022	Compatibility note added in section 5.
1.2	Mar 2023	Updated section “Software Development Tools” on page 14.

3. Reference Documents and Software

The following items may be useful in understanding and using the EVB.

- EVB Schematic
- Apollo4 Plus SoC Datasheet
- Apollo4 Family Programmer’s Guide
- Apollo4 Plus Errata List
- AmbiqSuite SDK

4. Quick Start

The Apollo4 Plus Display Kit comes with the following items:

- Apollo4 Plus Evaluation Board (EVB), revision 2
- Apollo4 Plus Display Shield, revision 1
- USB Type C cable
- Four adhesive-backed rubber feet
- Extra jumpers

Caution: The EVB has components loaded on the back of the board. Care should be taken to not damage these components. The included rubber feet should be applied to the bottom of the board to prevent direct contact between the components and a desk surface.

The EVB in the Apollo4 Plus Display Kit comes with jumpers pre-configured for default operation. Also, it has been pre-programmed with the Binary Counter example program. To begin EVB program execution, first carefully attach the Apollo4 Plus Display Shield to the Apollo4 Plus EVB if not already attached. To do this, press the two boards together as evenly as possible until the display shield is fully seated on the connectors of the EVB. Then connect the USB-C cable from a USB port on a PC to the J-Link USB connector (J6) on the EVB, and make sure the power switch (SW4) has been turned on. The LEDs on the bottom of the EVB should begin to count up in binary, from 0 to 7.

The AmbiqSuite SDK provides many example programs that may be run on the Display Kit. To run these examples, download the SDK via the link provided above and select any of the pre-built examples in the SDK at /boards/apollo4p_evb_disp_shield_rev2/examples.

5. Overview of the Apollo4 Display Kit

The Apollo4 Plus Display Kit consists of two PCB assemblies:

1. The Apollo4 Plus EVB (AMAP4PEVB), revision 2 or later
2. The Apollo4 Plus Display Shield revision 1

Please note that the Apollo4 Plus Display Kit is only compatible with the (non-blue) Apollo4 Plus EVB, part number AMAP4PEVB.

The combined features of the two-board assembly are shown in the block diagrams of Figure 2 and Figure 3. When MSPI0 is used in hex mode (16-bit interface), MSPI1 cannot be used, as the MSPI0 upper data lines use the same pins on the Apollo4 Plus that MSPI1 uses. An Apollo4 Plus GPIO pin, GPIO34, is used to select between using this set of pins as MSPI1 connections or as the upper data lines of MSPI0 in hex mode.

Figure 2 represents the two-board assembly's feature set when connected to the APS256XXN PSRAM device over MSPI0 in hex mode. MSPI1 is not used in this configuration.

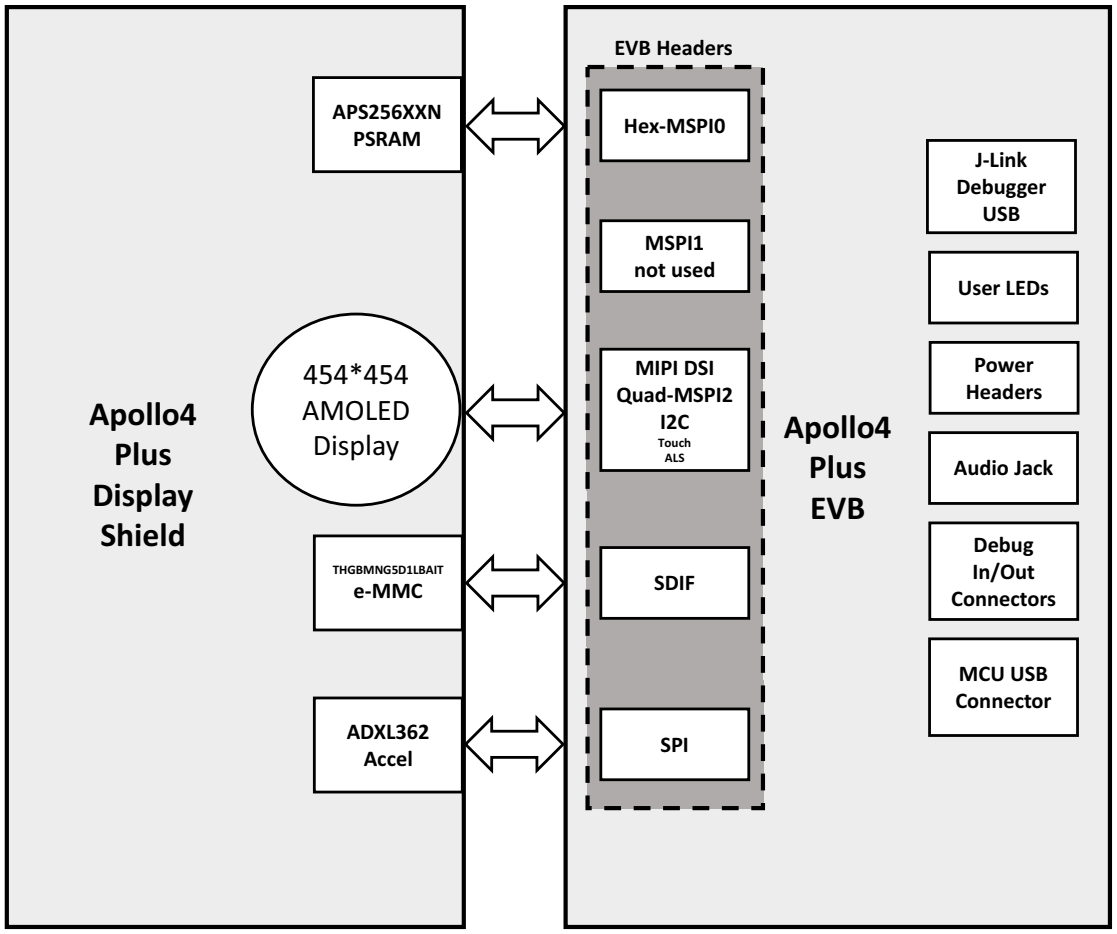

Figure 2. Apollo4 Plus Display Kit Block Diagram - MSPI0 Hex to PSRAM Only

Figure 3 represents the feature set and connections when using octal mode for both MSPI0 and MSPI1 connected to the APS256XXN PSRAM and IS25WX064 Flash device, respectively.

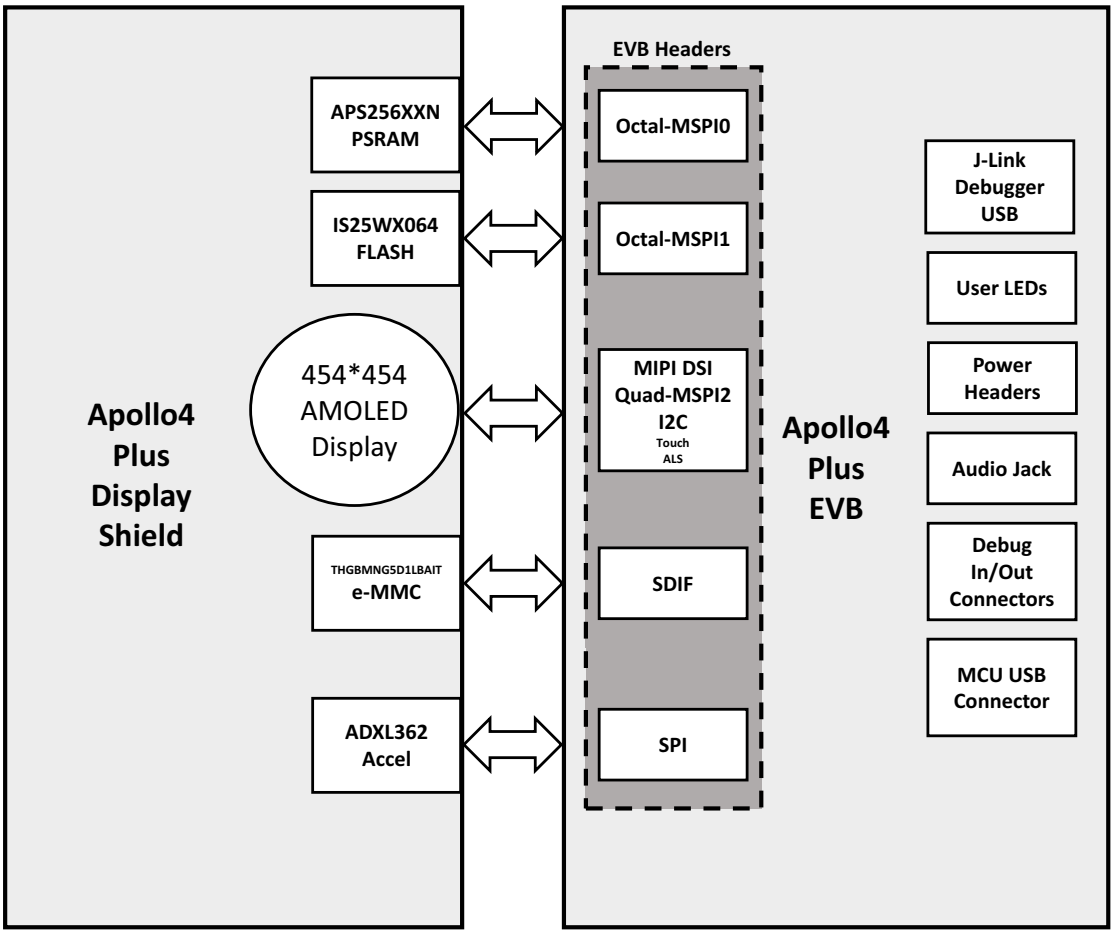

Figure 3. Apollo4 Plus Display Kit Block Diagram - MSPI0/MSPI1 Octal to PSRAM/Flash

Figure 4 identifies the major components on the Display Shield.

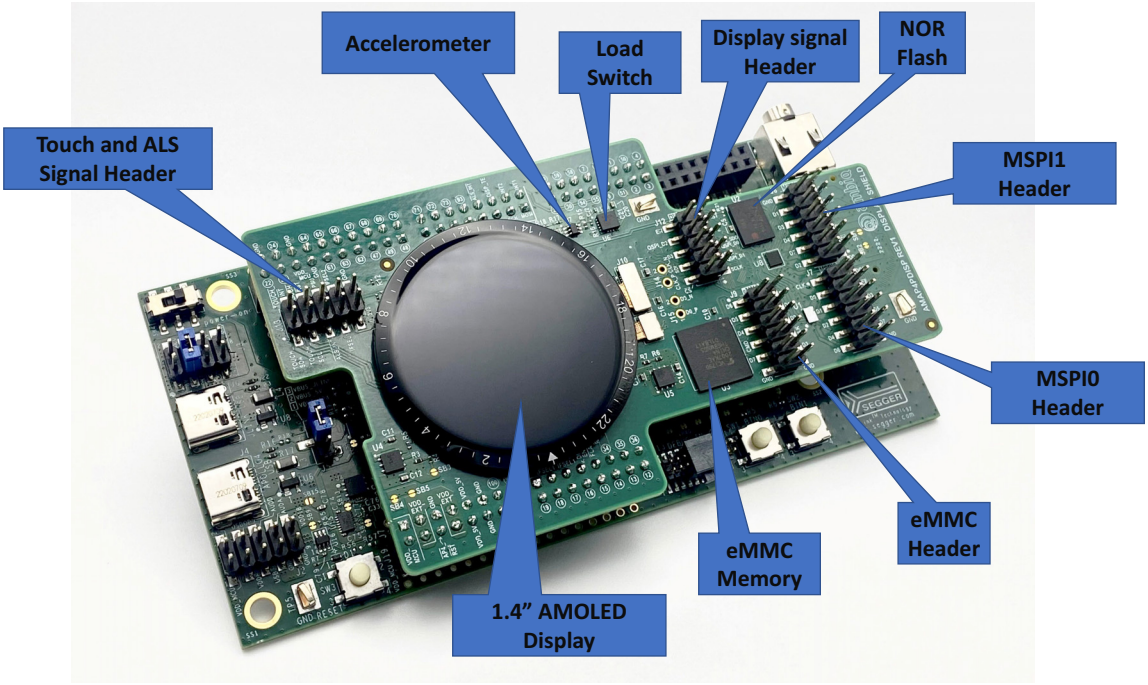

Figure 4. Apollo4 Plus Display Shield Parts Locations

The Display Kit has these additional features:

- Apollo4 Plus Display Shield
  - 1.4" 454*454 Pixel MIPI AMOLED Display
  - Display Laminated Capacitive Touch Sensor - TMA525C
  - 256 Mb HexSPI Double-Data-Rate (DDR) Enabled PSRAM - APS256XXN
  - 64Mb Octal-SPI DDR-enabled flash memory - IS25WX064
  - 4 GB x1/x4/x8 e-MMC module - THGBMNG5D1LBAIT
  - 3-Axis MEMS accelerometer - ADXL362
- Apollo4 Plus AMAP4PEVB Evaluation Board
  - USB Type C connector for power/download/debug
  - USB Type C connector for power/data to Apollo4 Plus
  - Segger J-Link debugger
  - Debugger-in port (SWD or ETM)
  - Three user-controlled LEDs
  - Two push buttons for application use, plus a reset push button
  - Power slide switch with LED power indicator
  - 3.5 mm Audio Jack (SJ-435107) for evaluating low-power analog audio interface

For a full overview of the Apollo4 Plus EVB's offerings, please refer to the AMAP4PEVB Quick Start Guide, which includes information about the debug interface.

Caution: The EVB has components loaded on the back of the board. Care should be taken to not damage these components.

NOTE

The Apollo4 Plus Display Shield and the Apollo4 Display Shield are not compatible with each other due to pin differences. The Apollo4 Plus Display Shield must be used with the Apollo4 Plus EVB (AMAP4PEVB), and the Apollo4 Display Shield must be used with the Apollo4 EVB (AMAP4EVB).

Each display kit has its own board support package (BSP) provided in the AmbiqSuite SDK. Support for the Apollo4 Plus Display Shield started in release 4.3.0.

Aside from pin differences, other differences between the two display shields are the following Apollo4 Plus Display Shield features:

- The MSPI1 flash device was changed from Adesto ATXP032 used on the Apollo4 Display Shield to ISSI IS25WX064.
- A mux was added to swap between the upper data pins of the MSPI0 hex interface to the PSRAM (MSPI1 not used) and MSPI1 octal interface to the IS25WX064 DDR Flash, as described at the beginning of this section.

5.1 Secure Boot on the Apollo4 SoC

Apollo4 Plus SoC parts from the Ambiq Micro factory are preprogrammed with a Secure Bootloader and an uninitialized Customer Info Space, referred to as INFO0. Initial provisioning of the part would include programming a valid INFO0 and programming the main firmware image in the flash. The Apollo4 Plus EVB is shipped with the INFO0 configuration pre-programmed with optimal settings for the EVB layout:

1. Default boot to non-secure mode.
2. Enable Boot Override to Push Button on GPIO18 (OTP setting) - BTN0/SW1.
3. Enable wired updates over UART0.
    A. UART0 is mapped to JLINK (OTP Setting).
    B. Baud rate is 115200 bps, no-parity, 8-bit data length, no flow control.
    C. Timeout is 3 seconds.

For your reference, the following settings are programmed into INFO0 on the Apollo4 Plus SoC resident on the EVB:

- Simo Buck is NOT enabled.
- Secure Bootloader (SBL) interface is configured to UART using GPIO47 and GPIO60, which allows secure boot to be performed over the J-Link COM interface of the EVB.
- SBL override pin is configured to GPIO18 which is BTN0/SW1 on the EVB.
- All Flash and Debugger protection features are disabled.

For information on changing the INFO0 settings as well as using the Secure Bootloader, please refer to the *README.txt file*, which can be found in the tools\apollo4b_scripts folder of the latest SDK release supporting the Apollo4 Plus family. This folder contains a number of python scripts to demonstrate generation of INFO0 settings, customer main images, and the creation of images for the Wired Update protocol over UART.

6. Software Development Tools

The standard Segger J-Link debug interface is used on the EVB for this Display Shield. Please install the latest Segger J-Link software, and configure your preferred development IDE (Keil, IAR, or Eclipse) to use the J-Link debug interface. Please consult the release notes of the latest/applicable SDK release for the version of the tools used during testing of the SDK and which are recommended for development with the SDK.

Links to the supported development tools are listed below.

- SEGGER J-Link Software: https://www.segger.com/downloads/jlink
- KEIL uVision 5 (ARM Compiler 5): https://www.keil.com/demo/eval/arm.htm
- Latest Keil Pack (CMSIS Ambiq Pack): http://www.keil.com/dd2/pack/#/third-party-download-dialog
- IAR IDE/Compiler: https://www.iar.com/iar-embedded-workbench/tools-for-arm/arm-cortex-m-edition/
- GCC (GNU Arm Embedded Toolchain): https://gcc.gnu.org

Regardless of IDE used, please install the Segger J-Link software. All of the above development environments support J-Link, but you must have the latest J-Link software installed. Most alternate development environments also support J-Link.

Please refer to the AmbiqSuite SDK Getting Started Guide for more details on setting up development IDEs to use J-Link.

7. Graphics Development Tools

The Apollo4 Plus Display Kit supports the Nema®|GUI-Builder GUI Builder from Think Silicon (https://www.think-silicon.com/?section=2183&language=en_US). The tool offers various color formatting, display widgets, animations and other features written in the C programming language. The NEMA®|GUI-Builder interfaces directly with the Apollo4 Plus's GPU and provides a software abstraction layer to organize and employ drawing commands, while requiring minimum CPU/MCU usage and power consumption.

Required system resources are as follows:

- **OS:** Windows® (10), Linux® (Ubuntu 32/64-bit)
- **Screen Resolution:** 800×600 or higher
- **RAM:** 256MB
- **Storage:** 100MB available space

The Nema|Gui-Builder offers the following features.

Color Formats

- Support for multiple color formats for both source and destination textures
- 32-bit: RGBA8888 / BGRA8888 / ABGR8888
- 24-bit: RGB
- 16-bit: RGBA5551 / RGB565
- 8-bit: A8 / L8 / RGB332
- 4-bit: A4 / L4
- 2-bit: A2 / L2
- 1-bit: A1 / L1
- TSC (see GUI-Builder documentation for details)

Widgets

- Label button
- Icon button
- Radio button
- Horizontal slider
- Vertical slider
- Digital meter
- Icons
- Progress bar
- Gauge
- Circular progress
- Watch face

Transitions and Animations

- Alpha blending
- Programmable size, offset and format per layer
- Programmable stride/pitch enabling panning and clipping

Other Features

- Transparency
- Color keying
- Multi-function image processing

8. Hardware Configuration Options

8.1 Power Supply Configuration

The Apollo4 Plus Display Shield is connected to the AMAP4PEVB hardware through each of the five GPIO headers present on the EVB, as well as the high-speed connector, and as a result the display shield derives its power supplies from the 5V USB supply of the EVB. The two derived power supplies are:

- VDD_1V9_PSU – Default 1.9V, configurable to 1.8V by shorting solder-bridge SB3
- VDD_3V3

The VDD_1V9_PSU rail is by default the source of power for the SHIELD_PSU rail, which is the supply for each of the 1.9V on the display shield. However, by using solder bridges SB4 and SB5, the user can configure the SHIELD_PSU rail to be supplied by an external supply, VDD_MCU of the Apollo4 EVB, or by the default option of VDD_1V9_PSU.

- External Supply – Open SB4, Short SB5 on Display Shield, connect external supply to VDD_EXT on J3 of AMAP4PEVB.
- VDD_MCU of AMAP4PEVB – Open SB4, Short SB5, connect jumper between VDD_EXT and VDD_MCU on J3 of AMAP4PEVB.

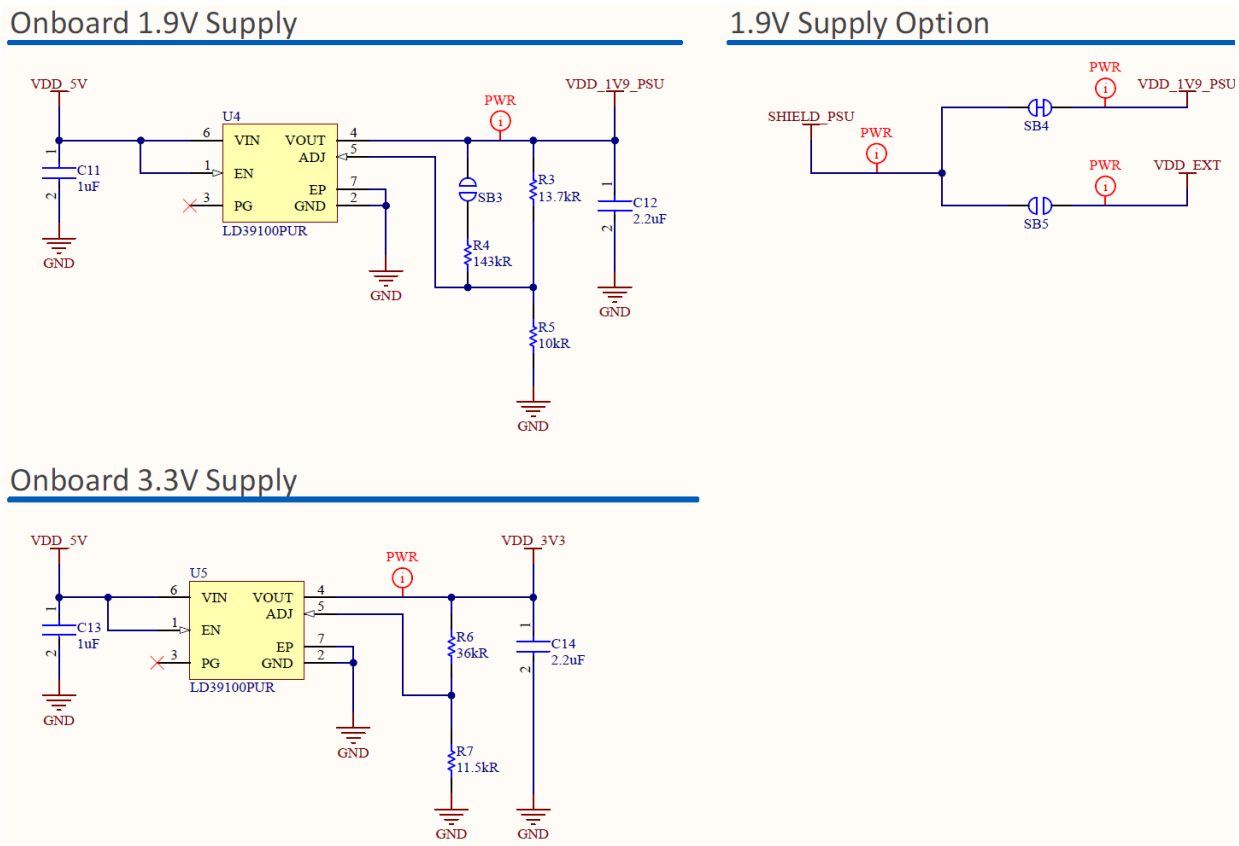

Figure 5. PSU page of the Display Shield schematic

By using an external supply, or the on-board VDD_1V9_PSU rail, the user is able to take accurate current measurements of the Apollo4 Plus under a variety of conditions offered by the Display Kit without extra load on the Apollo4 Plus SoC rails. Please consult the AMAP4PEVB Quick Start Guide for details on taking current measurements with the Apollo4 Plus EVB.

8.2 eMMC/SPI Solder-Bridge

Solder-bridges 1 and 2 are used to select between the SDIF_DAT4 (eMMC_D4) and DISP_SPI_SDI (AP4_DISP_SDI) hardware connections for the GPIO79 pin. By default, the hardware is configured to connect to the e-MMC device.

Figure 6. GPIO79 Pin Connection Options

8.3 Other Solder-bridge Options

For other solder-bridge options, please consult the Apollo4 Plus EVB Quick Start Guide.

9. Ordering Information

Table 2: EVB / Shield Ordering Information

Device Name	Orderable Part Number	Board Revision	SoC	SoC Package	Availability
Apollo4 Plus Display Kit[a]	AMAP4PDISP	EVB Rev. 2 / Shield Rev. 1	Apollo4 Plus	5.0 x 5.0, 146-pin BGA	4Q2022

a. Includes Apollo4 Plus EVB and Apollo4 Plus Display Shield

Table 3: SoC Ordering Information

Device Name	Orderable Part Number[a]	MRAM	RAM	Package	Packing	Operating Temperature Range	Availability
Apollo4 Plus SoC	AMAP42KP-KBR	2 MB	2.75 MB	5.0 x 5.0, 146-pin BGA	Tape and Reel	-20 to 60°C	Now

a. The silicon revision is identified by the first letter in the bottom row of the package's top marking.

Ambiq Micro, Inc.
6500 River Place Boulevard, Building 7,
Suite 200, Austin, TX 78730-1156
www.ambiq.com/
sales@ambiqmicro.com
https://support.ambiqmicro.com
+1 (512) 879-2850

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